Low-Temperature Thermal Treatment of Chlorinated-Benzene Contaminated Soil Using an Innovative Batch Treatment System

Eastland Woolen Mill Superfund Site, Corinna, Maine

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US Army Corps of Engineers®
New England District

WESTON SOLUTIONS℠

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Presentation Outline

- Introduction
- Soil Description
- Treatment Objectives
- Process Description
- Process Optimization
- Project Monitoring
- Conclusions

Introduction – Site Description

- Located in Corinna, Maine, 25 miles northwest of Bangor
- Textile mill operated between 1936 and 1996
- The dye-aid contained chlorobenzene compounds
- Mill operations resulted in discharges of process wastewater to the river, contaminating the river sediments, groundwater, and soil underlying portions of downtown Corinna
- Bankruptcy forced the mill’s closure in 1997 and the Site was placed on the EPA NPL in 1999

Introduction – NTCRA Scope

- Building demolition
- Main Street, bridge and river relocation
- Excavation of contaminated soil
- **On-site thermal treatment of 100,000 tons of contaminated soil**

Aerial of Mill

Photo courtesy of *The Cattail Press*

Soil Description

- Glacial till, silty-sand to sandy-gravel
- Screened to <1.5 inches diameter
- Particle size: 19 – 28% fines (<0.075 mm dia.)
- Moisture content: 5 – 12%
- pH: 8.4 – 9.3
- Total organic carbon: 100 – 12,800 mg/kg

TABLE 1. Treatment Goals and Pre-Treatment Concentrations in the Soil

Contaminant of Concern	Contaminant Concentration (mg/kg)		
	Treatment Goal	Average Pre-Treatment	Maximum Pre-Treatment
1,2,4-Trichlorobenzene	15	72	620
1,2-Dichlorobenzene	6	13	140
1,3-Dichlorobenzene	6	0.8	7.7
1,4-Dichlorobenzene	3	9.6	65
Chlorobenzene	3	2.6	45

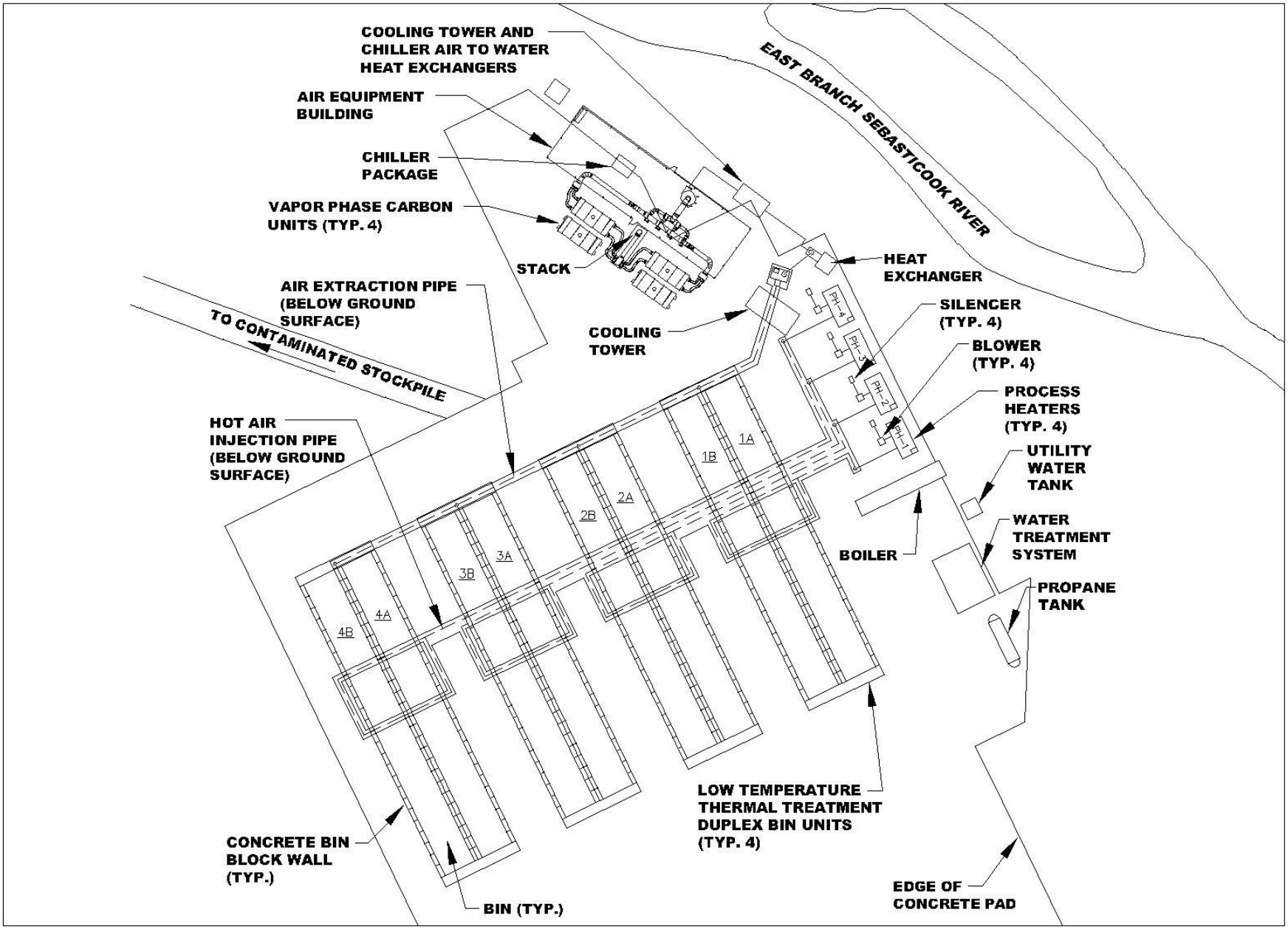
Treatment Objectives

- Thermal treatment using indirect-fired low temperature system
- Treat soil to below soil treatment goals for reuse on-site
- Complete all soil treatment by December 2004 (within 3 years)
- Maximum annual operating budget of $7M

Process Description

- Indirect-fired, batch, low-temperature thermal treatment system (LTTT)
- One time mob/demob and low downtime costs
- System Components
  - Treatment bins
  - Hot air injection system
  - Process emissions extraction and treatment
  - Control and monitoring equipment

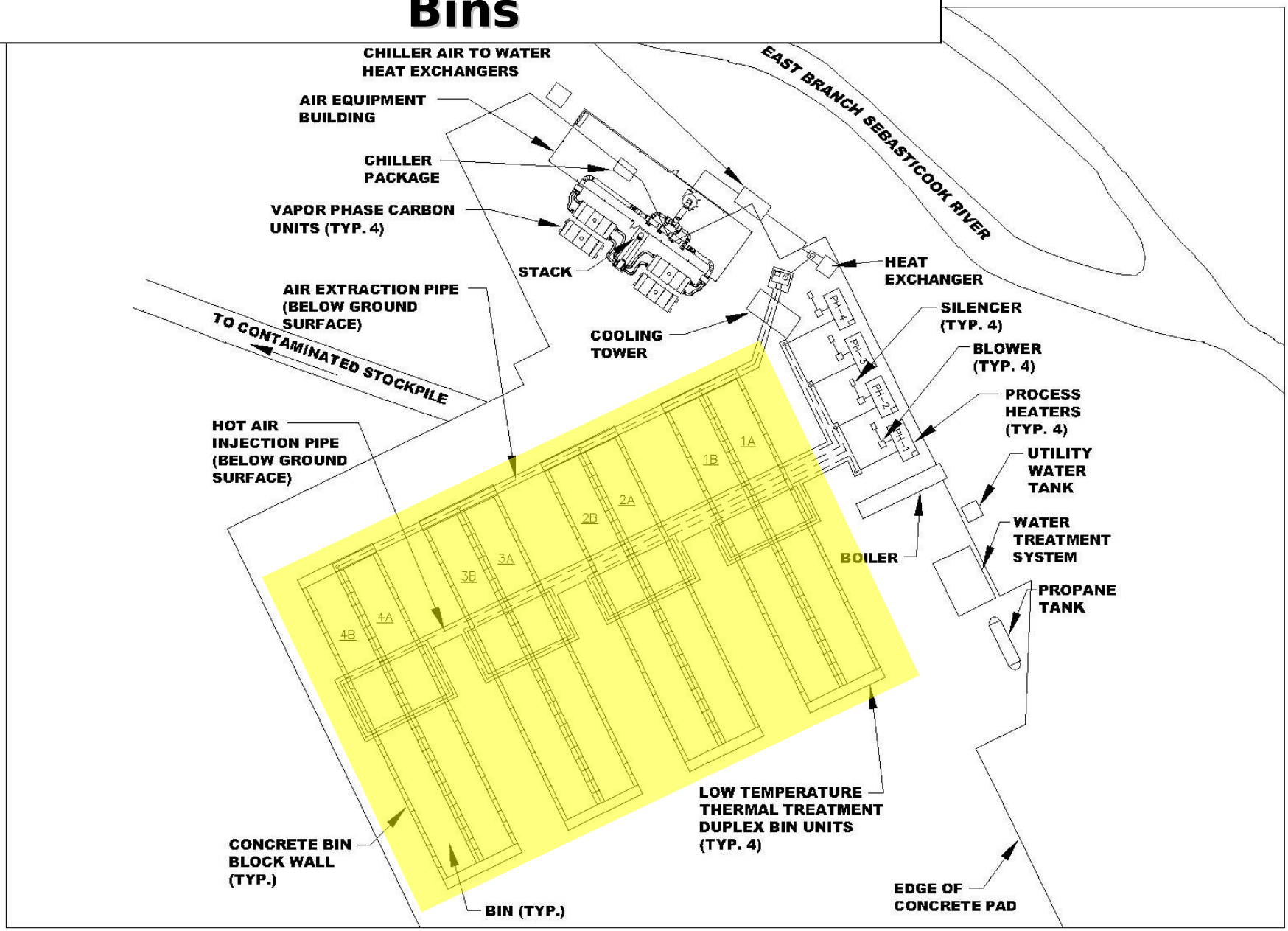
LTTT System Layout



Aerial of LTTT System Construction

Photo courtesy of *The Cattail Press*

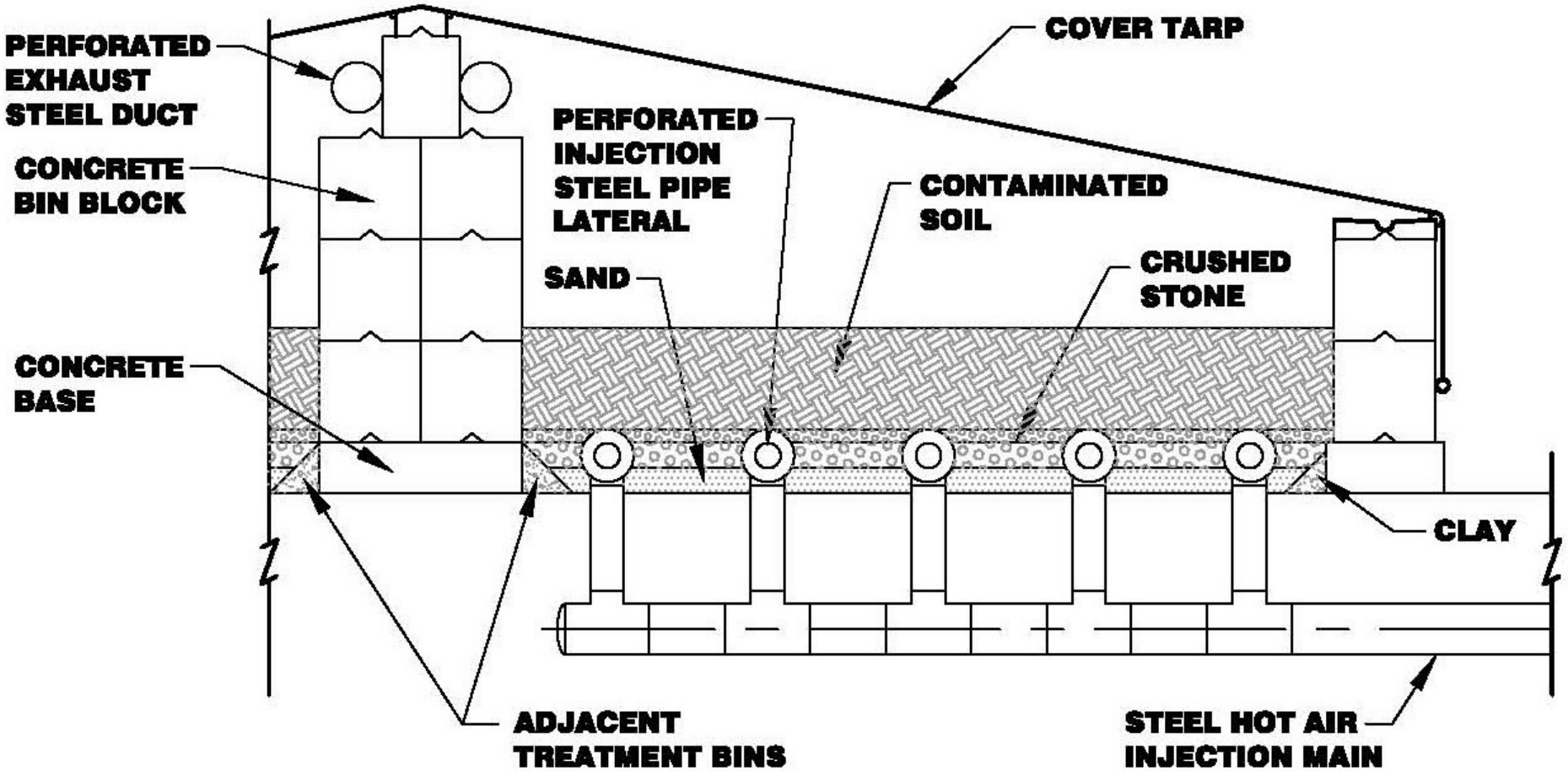
LTTT System Layout – Treatment Bins



Treatment Bins

- Four duplex units (8 bins)
  - Each bin 156 ft x 16 ft (500 ton soil capacity)
  - Walls constructed of concrete blocks
  - Removable end plates
  - End ramps
  - Stone below soil
  - Removable cover tarps

Treatment Bin Construction and Piping

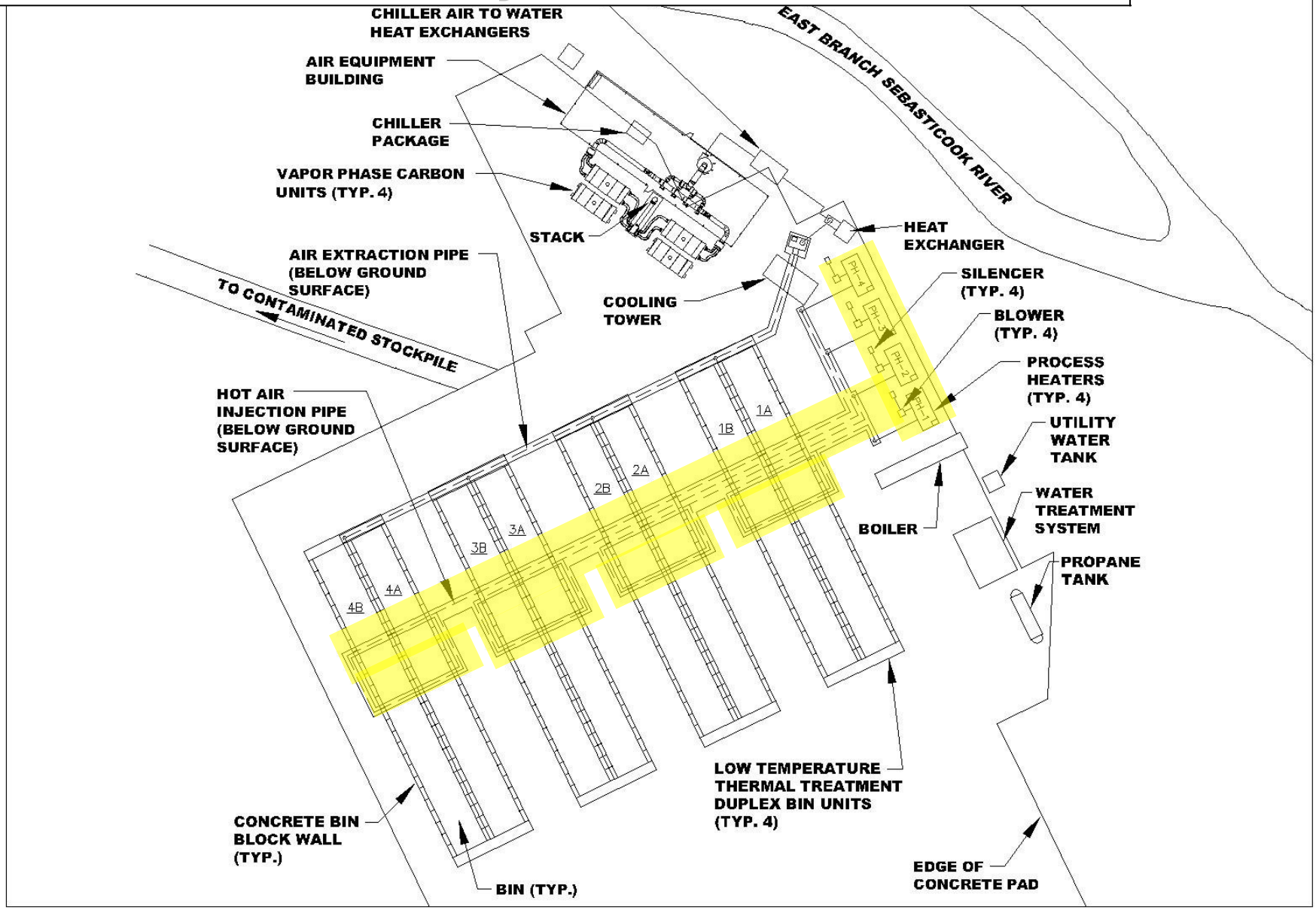


Treatment Bin Piping and Walls

Treatment Bin Stone Layer

Treatment Bin Cover Tarps

LTTT System Layout – Hot Air Injection System



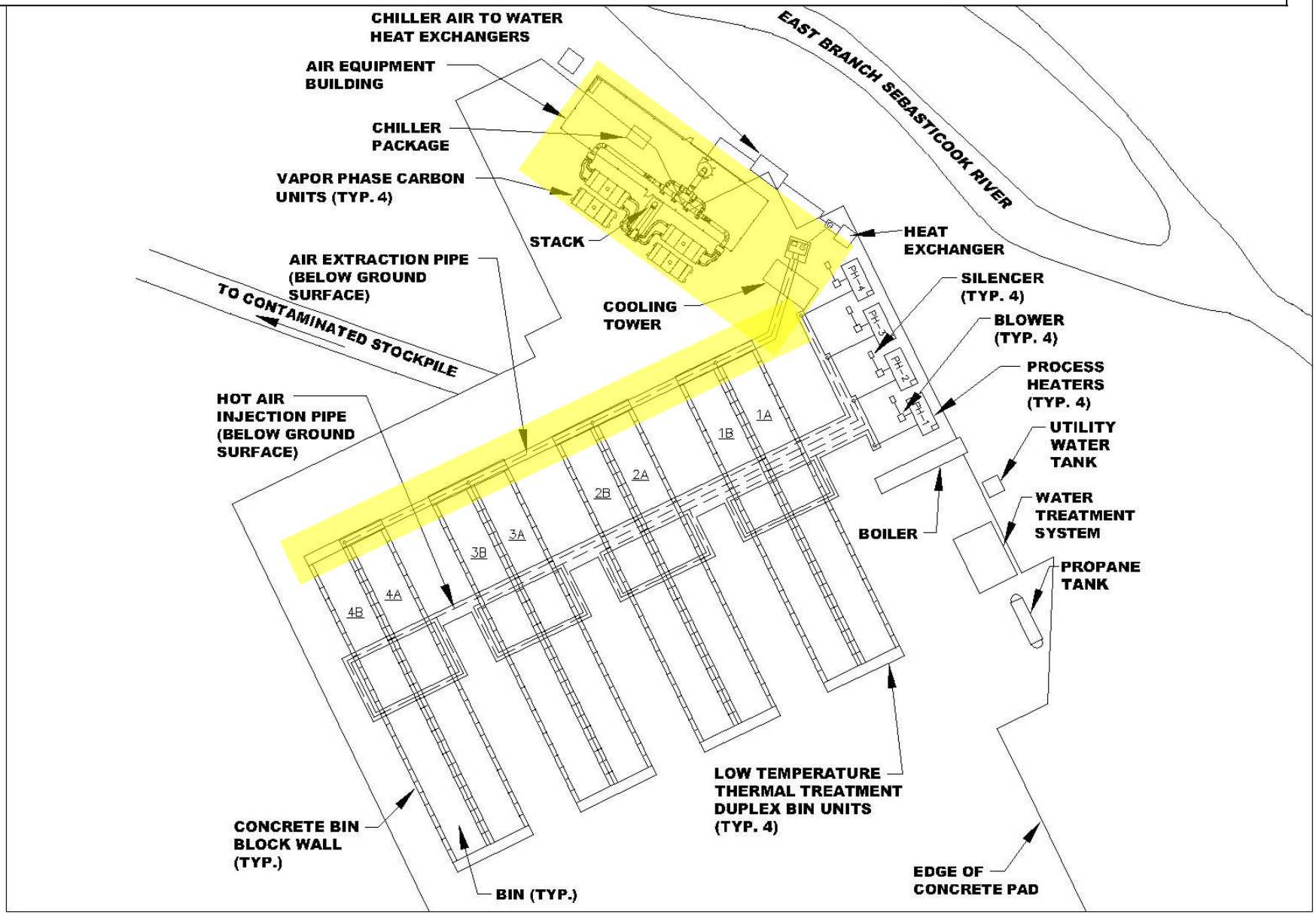
Hot Air Injection System

- Hot air
  - Four 2M Btu indirect-fired heater units
  - 350 hp boiler for steam addition
  - Propane fuel source
- Injection piping
  - Steel main pipes and perforated injection pipes in bin
  - Underground installation

Indirect-fired Heaters

Underground Injection Pipe

LTTT System Layout – Process Emissions Treatment



Process Emissions Extraction and Treatment

- Air collection system to maintain negative pressure in bins
  - Perforated pipe in bins and underground main
  - Blowers
- Treatment train to reduce air temperature and relative humidity
  - Air-to-air heat exchanger
  - Water-to-air heat exchanger connected to cooling tower
  - Knockout tanks
- Vapor-phase activated carbon

Emissions Collection and Extraction Pipe

Blowers and Knockout Tank

Air-to-air HEX and Activated Carbon Unit

Control and Monitoring Equipment

- Airflow, air temperature, air pressure, relative humidity
- Soil temperature

Process Optimization

- Efficient material handling
- Performance testing and modeling
- Laboratory analytical and data management procedures

Material Handling

- Pre-screening
- Clean haul roads
- No compaction during soil placement in bins
- Removal of individual grids with excavator bucket

Performance Testing and Modeling

- Trichlorobenzene thermal desorption computer model
  - LTTT treatment time reduced at moist, low temperature conditions (high contaminant vapor pressure)
- Field performance tests
  - Majority of contaminant mass removed in 4 days
  - Treatment efficiency same for soil depth 1 – 3.5 ft
  - Treatment efficiency same for target temps 140 – 165˚F
  - Target temperature reached in 24 hrs
  - Maintaining moisture content of soil was critical for performance

TABLE 2. Optimum Treatment Conditions for the System

Air Flow (per bin)	**750 – 1200 acfm**
Air Injection Temperature	**Approx. 175˚F**
Steam Injection Rate (per bin)	**800 – 1000 lb/hr**
Target Soil Temperature	**150˚F (minimum 140˚F)**
Soil Depth	**3.5 ft**
Treatment Duration at Target Temperature	**5 days (minimum 4 days)**

acfm = actual cubic feet per minute

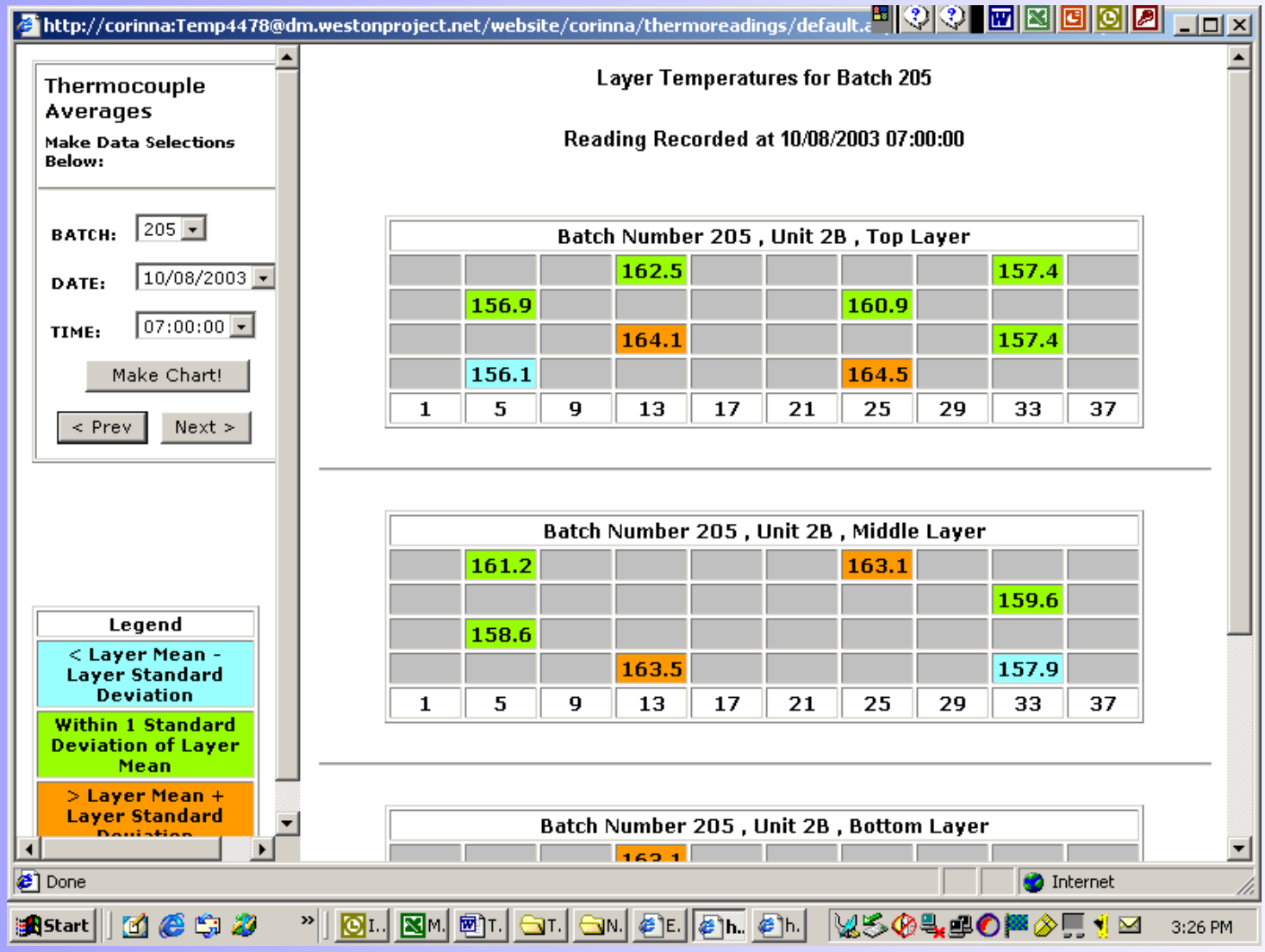
Laboratory Analytical and Data Management Procedures

- On-site laboratory
  - Extensive QC requirements
  - Immediate data validation by project chemist
- Data management
  - EDD loaded into laboratory analytical database
  - Operations data compiled in operations database
  - Two databases linked to produce *Batch Tracking Form* for QC and QA sign-off

Project Monitoring

- Web-based virtual private network (*TeamLink*℠)
  - Laboratory analytical (daily upload) and operational (real-time) data
  - Data summaries
  - Automated table and graph generation
  - Query functions
  - Accessible to WESTON senior technical staff, CENAE, EPA, and MEDEP

Web-based LTTT System Monitoring Example



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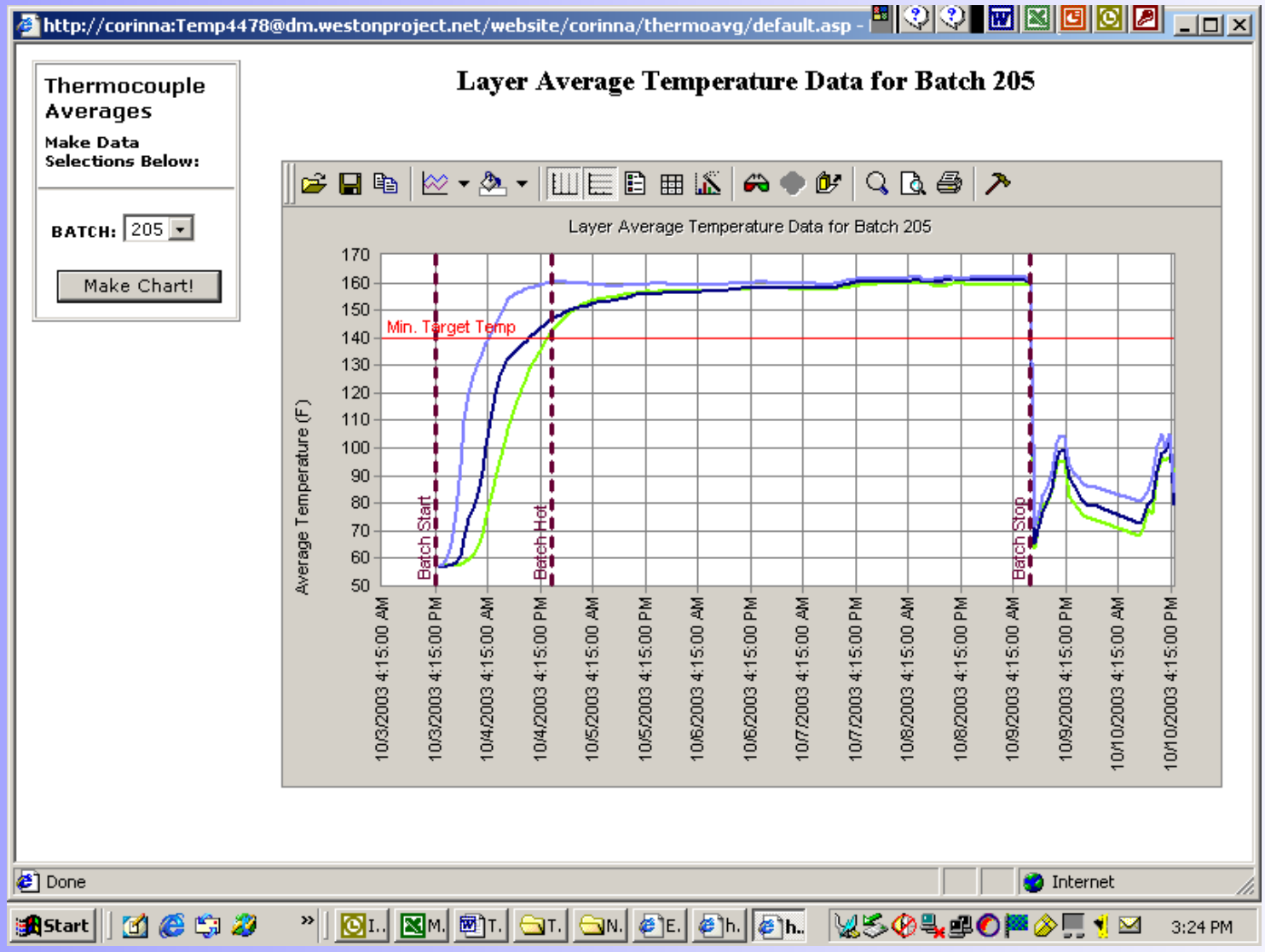


Conclusions

- Total of 92% of soil treated through system met treatment goals for on-site reuse
- Total of 7,000 tons treated sufficiently to ship off-site for further treatment and disposal
- LTTT system generally achieved 92% mass removal for all contaminants of concern

TABLE 3. Post-Treatment Concentrations in the Soil and Percent Contaminant Removal Achieved

Contaminant of Concern	Contaminant Concentration (mg/kg)		Percent Contaminant Removal Based on Average Pre- and Post-Concentrations
	Treatment Goal	Average Post-Treatment	
1,2,4-Trichlorobenzene	15	5.6	92%
1,2-Dichlorobenzene	6	0.73	94%
1,3-Dichlorobenzene	6	0.28	66%
1,4-Dichlorobenzene	3	0.66	93%
Chlorobenzene	3	0.17	93%

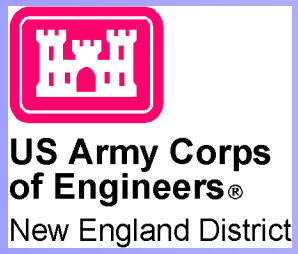
Conclusions (continued)

- LTTT activities completed in October 2003, 12 months ahead of 3 year schedule
- Average throughput rate during full-scale operations was 600 tons/day (25 tons/hour)
- Overall treatment costs were $13.1M, within phased funding budget and below estimated cost for conventional thermal desorption

LTTT system provided best value to the government under phased funding conditions.

Acknowledgements

- Ken Dow of *The Cattail Press* for aerial photographs included in the presentation
- Dr. Myron Kuhlman of MK Tech Solutions, Inc. for computer simulation of thermal desorption of trichlorobenzene
- Dr. Ian Osgerby of CENAE for guidance and support of the innovative technology



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